Giant Turbines

being elaborated, which is almost equal to the capacity of the entire Kakhovka Hydro Power Plant. The application of a forge-welded rotor and a new type of blade, 780 mm in length, made it possible to reduce the over-all size of a 150,000 kw turbine, to the over-all size of the 100,000 kw generator, which means reducing its weight by 1½ times for each kw produced and shortening the length of the turbine by 7 m. By introducing slightly different methods in the production and output of high-strength steel, the pressure in the turbine can be raised up to 130 atm and the temperature to 565°C. This method provides the possibility of producing more economical turbines of a capacity of 100,000, 150,000 and 200,000 kw within the next 2 or 3 years. Already during the 5th Five-Year Plan, a steam turbine with a capacity of 150,000 kw, operating under a pressure of 170 atm and a temperature of 550° C, was built by the Leningrad Metal Plant (Leningradskiy metallicheskiy zavod). A considerable quantity of austenitic steel was used for the construction of this turbine. Designers and scientists of the Soviet Union are of the opinion that when using this austenitic steel for the construction of turbines, a pressure of 220 atmospheres and a temperature of 600°C - with special constructions even of

(Khar'kovskiy turbinnyy zavod imeni S.M. Kirova)

SHUBENKO-SHUBIN, L.A.

25(2) PHASE I BOOK EXPLOITATION SOV/1636

Novyye mashiny; sbornik statey o novykh mashinakh, motorakh, apparatakh sozdannykh na Khar'kovskikh predpriyatiyakh v period 1956-1958 gg. (New Machines; Collection of Articles on New Machines, Motors, and Apparatus Made in Khar'kov Plants From 1956 to 1958) /Khar'kov/ Khar'kovskoye oblastnoye izd-vo, 1958. 226 p. 4,000 copies printed.

Compiler: P.I. Zmaga; Scientific Eds.: V.A. Bulgakov (Chief Enggineer, Khar'kov Electromechanical Plant), S.A. Vorob'yev (Candidate of Technical Sciences, Docent), L.A. Shubenko-Shubin (Chief Machine Designer, Khar'kov Turbine Plant, and Corresponding Member, Ukrainian SSR Academy of Sciences); Ed.: Ya.Ye. Donskoy; Tech. Ed.: M.G. Shevchenko.

PURPOSE: This collection of articles is to acquaint the reader with the latest developments and attainments of the Khar'kov machinery manufacturing industry during the 1956-58 period.

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COVERAGE: The book, prepared in the form of a descriptive catalog, presents the latest information on machinery and equipment manufactured by Khar'kov plants from 1956-58. A detailed description is given of the following machines and equipment: steam turbines, tractors, self-propelled chassis, diesel engines, diesel locomotives, machine tools including unit metal-cutting machine tools, conveyors, road building machinery, electric power generators, and electrical and electronic instruments. Numerous photographs of the above-listed machinery and equipment are included in the text. No personalities are mentioned. There are no references.

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New Machines; Collection of Articles (Cont.) SOV/1636

MACHINES AND MACHINE TOOLS

Shubenko-Shubin, L.A., Chief Designer at the Khar'kov Turbine Plant imeni Kirov, Corresponding Member of the Academy of Sciences of the UkrSSR. New Powerful Steam Turbines Manufactured by the Khar'kov Turbine Plant imeni Kirov 25

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[Aerodynamics of the blading of steam and gas turbines] Aerodinamika protochnoi chasti parovykh i gazovykh turbin. Pod red. I.I. Kirillova. Moskva, Gos. nauchno-tekhn. izd-vo mashinostroit. lit-ry, 1958. 246 p. (MIRA 11:10)

1. Bryanskiy institut transportnogo mashinostroyeniya (for Kirillov).
2. Chlen-korrespondent Akademii nauk USSR (for Shubenko).

(Tubromachines--Aerodynamics)

UKR SSR

SHUBENKO, L.A.

Experience in improving the blading of steam turbines of the Kharkov Turbine Plant. Energomashinostroenie 4 no.7:1-4 Jl '58. (MIRA 11:10)

1. Chlen-korrespondent AN USSR.
(Steam turbines)

SOV/96-59-2-1/18

AUTHOR: Shubenko-Shubin, L.A., Corresponding Member of the Academy of Sciences UkrSSR

TITLE: Steam Turbines of the Khar'kov Turbine Works - on the 25th Anniversary of the Works (Parovyye turbiny Khar'kovskogo turbinnogo zavoda (k-25-letiyu KhTGZ))

PERIODICAL: Teploenergetika, 1959, Nr 2, pp 3-15 (USSR)

ABSTRACT: This article is a general review of the main types of turbine constructed at the Khar'kov Turbine Works, followed by an outline of future plans. The factory commenced operations in January 1935, making 50 MW turbines, types AK-50, to the drawings of the American General Electric Company. In its day this was the most powerful single-cylinder turbine made in the USSR and in all some 25 of them were made. Although many features of this design are now out-of-date others have proved their value and are retained still. A major step forward was the manufacture in 1938 of turbine type AK-100, of 100 MW at 1500 r.p.m. with steam conditions of 29 atm, 400°C, illustrated in Fig 2. This particular turbine was destroyed during the war and rebuilt in 1945.

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The way in which certain constructional features of

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Steam Turbines of the Khar'kov Turbine Works - on the 25th Anniversary of the Works

this turbine developed from the corresponding features of the AK-50 turbine is briefly stated. In the pre-war years the Khar'kov Turbine Works also made ships' turbines and reduction gears. Immediately after the war, in 1945-46, designs were prepared for a whole new series of turbines operating at steam conditions of 90 atm and 500°C. For a number of reasons the only one of these actually manufactured was the single-cylinder 25 MW type VR-25-1 with back-pressure of 31 atm for super-position on medium pressure (29 atm) stations and type VR-25-2 with back-pressure of 18 atm for industrial process requirements. The first turbine type VR-25 was built in 1948 and more than 30 have now been built. A cross-sectional drawing of the turbine is given in Fig 3 and the construction is described. These turbines type VR-25 were the first to be built in the USSR for steam conditions of 90 atm and 500°C and they proved very reliable. Tests made at power stations showed that the first three of these turbines were some four to

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five per cent less efficient than expected but this difficulty was overcome by a subsequent re-design of the blading. Steam turbines type VKT-100 of 100 MW at 3,000 rpm with steam conditions of 90 atm, 535°C and a condenser pressure of 0.03 atm were built in 1957 and a photograph is given in Fig 4. In designing this turbine the main problem was to raise the efficiency of the set whilst maintaining the stop valve pressure at 90 atm and increasing the temperature as far as possible consistent with the use of pearlitic class steels. This type of turbine was found to be particularly efficient, largely because of the advanced blading design. A schematic diagram of the thermal circuit of turbine VKT-100 is given in Fig 5; there are 17 stages in the high-pressure cylinder and 4 stages in each of the two halves of the low pressure cylinder. The efficiency of the new types of blading was demonstrated by reconstructing a turbine type VR-25-1 which gave an increase in efficiency of about 5% for a given setting of the governor valve. Further improvements, which

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are described, resulted in the final increase in efficiency being 8%. The turbine type VKT-100 was the first of its kind to use rigid couplings between the rotors, the advantages of this construction are enumerated. Special arrangements were made to heat up flanges and other parts so as to permit rapid starting of the turbine. The hydrodynamic governor system is briefly described. In 1958 the works manufactured the first turbine type PVK-150 with an output of 150 MW at 3,000 rpm; this turbine is illustrated on the front cover of the journal. In this turbine the steam conditions at the stop valve are 130 atm and 565°C, which permits the use of only pearlitic class steel. Reheat to the initial temperature is used and the turbine and boiler are made as a unit. A schematic thermal diagram of turbine type PVK-150 is given in Fig 6, a cross-sectional drawing of the turbine is given in Fig 7, a photograph of the low-pressure rotor in Fig 8 and pictures of typical blades in Fig 9.

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Because of the use of a welded low-pressure rotor and a final low-pressure stage of very high capacity, it was possible to adopt a two-cylinder construction for this turbine. Some of the difficulties that had to be overcome in adopting these two features are described. Various constructional features of the turbine, particularly the blading and casing, are described in some detail. Semi-flexible couplings are used between the rotors. In 1958, the Khar'kov Turbine Works manufactured several turbines type PVK-150. In the next few years the production of these turbines will increase and they will become the main sets for new big condensing power stations. In southern parts of the country this type of turbine will be arranged to work in the open-air. New 25 MW back-pressure turbines have been made and are being developed. In 1955-56 the blading of turbines type VR-25-1 and VR-25-2 were modernised for operation on steam at 90 atm and 500°C. In 1957 the first turbines types VRT-25-1 and VRT-25-2 with initial steam conditions of 90 atm and 535°C were

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constructed and designs were prepared for a turbine type PVR-25-18 with a back-pressure of 18 atm for steam conditions of 130 atm and 565°C. A number of new design principles were proposed for turbine type SKR-100 of 100 MW with steam conditions of 300 atm and 650°C with reheat to 565°C. This turbine which operates with back-pressure of 35 atm is intended for superposition on medium pressure turbines. A two-cylinder design is used in which the low-pressure cylinder is made of pearlitic steel and the high-pressure cylinder includes austenitic steel. The principles of having some parts operating at high temperatures but relatively lightly stressed while other parts run at lower temperatures but are more heavily stressed can be extended to other parts of a turbine set and should make possible the use of still higher steam conditions. There is reason to suppose that, on the basis of the development work undertaken for turbine type SKR-100, it will soon be possible to make large turbines for steam

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temperatures of the order of 750 - 800°C using only familiar constructional materials, mainly non-austenitic. Turbine type SKR-100 is the prototype for the main part of a 300 MW turbine type SKKT-300 for steam conditions of 300 atm and 650°C with two reheats to 565°C, the designs for which were prepared in 1957. In the process of design it was found that the use of these steam conditions brings in a number of difficulties and the works consider that the development of such large sets for such steam conditions should be divided into two parts. Superposed turbines type SKR-100 should first be built and installed at a large medium-pressure power station. Experience with such sets should provide a basis for the development of 300 MW sets on a single shaft and also, later, two-shaft sets of 600 MW type SKK-600, which are at present being developed by the Khar'kov Works Design Staff. New non-austenitic steels are now being developed which can be used in turbines with steam conditions of 240 atm, 580°C with reheat to 565°C. The first models of

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SHUBENKO-SHUBIN, L.A.

Rotor blades of final stages of Soviet-made heavy steam turbines. Energomashinostroenie 5 no.1:3-8 Ja '59. (MIRA 12:2)

1. Chlen-korrespondent AN USSR.
(Blades) (Steam turbines)

SHUBENKO-SHUBIN, L.O.

Powerful steam turbines. Nauka i zhyttia 9 no.5:15-19
My '59. (MIRA 12:9)

1. Chlen-korrespondent AN USSR; glavnyy konstruktor Khar'kov-
skogo turbinnogo zavoda imeni S.M.Kirova.
(Steam turbines)

ARAKCHEYEV, A.A.; BEREZIN, S.P.; BELYAVSKIY, V.A.; KOLOTILOV, A.N.; MOLOKANOV, S.I.; NEKRASOV, A.M.; LAVRENENKO, K.D.; POLENTSEV, M.K.; ROZHDESTVENSKIY, A.P.; SATANOVSKIY, A.Ye.; SIRYY, P.O.; SPIRIDONOV, K.A.; CHERNYSHEV, P.S.; SHUBENKO-SHUBIN, L.A.

Savva Mikhailovich Zherbin; obituary. Elek.sta. 30 no.2:96 F '59. (MIRA 12:3)

(Zherbin, Savva Mikhailovich, 1903-1958)

SHUBENKO-SHUBIN, Leonid Aleksandrovich [Shubenko-Shubin, L.O.]; LABINOVA, N.M., red.izd-va; LIBERMAN, T.R., tekhn.red.

[Steam turbines for large thermal electric power plants] Parovi turbiny dlia potuzhnykh teplovykh elektrostantsii. Kyiv, Vyd-vo Akad.nauk URSR, 1960. 24 p. (MIRA 14:4)

(Steam turbines)

SHUBENKO-SHUBIN, Leonid Aleksandrovich; LISETSKIY, Nikolay Longinovich; SHVARTS, Viktor Aleksandrovich; KORZH, Petr Ivanovich; PROSKURA, G.F., akademik, retsenzent [deceased]; YERSHOV, V.N., dotsent, kand.tekhn.nauk, retsenzent; SOROKA, M.S., red.

[Atlas of drawings and diagrams of gas turbine units] Atlas konstruktsii i skhem gazoturbinnykh ustanovok. Pod obshchei red. L.A.Shubenko-Shubina. Moskva, Gos.nauchno-tekhn.izd-vo mashinostroit.lit-ry, 1960. 183 p. (MIRA 14:1)

1. Chlen-korrespondent AN USSR (for Shubenko-Shubin). 2. AN USSR (for Proskura).

(Gas turbines--Design)

SHUBENKO-SHUBIN, L. A.

PHASE I BOOK EXPLOITATION SOV/5452

Donskoy, Ya. Ye., G.I. Kardash, and I.P. Lyalyuk, eds.

Mekhanizatsiya i avtomatizatsiya; sbornik statey ob opyte vnedreniya mekhanizatsii i avtomatizatsii na khar'kovskikh mashinostroitel'nykh zavodakh (Mechanization and Automation; Collection of Articles on the Introduction of Mechanization and Automation in Khar'kov Machinery-Manufacturing Plants) [Khar'kov] Khar'kovskoye knizhnoye izd-vo, 1960. 373 p. 3,900 copies printed.

Editorial Board: S.A. Vorob'yev, Candidate of Technical Sciences; Chairman of the Editorial Board: P.I. Zenga, Engineer; A.A. Kotlov, Engineer, V.I. Kuzutov, Engineer, A. Ye. Leonov, Docent, A.I. Tupitsyn, Candidate of Technical Sciences, and S.M. Khaira, Candidate of Technical Sciences; Eds.: Ya. Ye. Donskoy, G.I. Kardash, and I.P. Lyalyuk; Tech. Ed.: M.I. Limanova.

PURPOSE: This collection of articles is intended for technical and scientific personnel, outstanding workers, and shock workers of communist labor.

COVERAGE: The multifaceted experience of Khar'kov enterprises in the mechanization, automation, and improvement of manufacturing processes is generalized. The development of new machines, instruments, and production methods is considered and attention is given to newly established enterprises, and to the introduction of telemechanics in the Khar'kov gas-system management. By including concrete examples and facts, the authors of the various articles attempt to demonstrate the achievements of the Khar'kov industrial complex in fulfilling the resolutions of the June (1959) and July (1960) Plenums of the Central Committee of the Communist Party of the Soviet Union. No personalities are mentioned. There are no references.

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SOV/96-60-2-1/24

AUTHOR: Shubenko-Shubin, L. A., Corresponding Member, Academy of Sciences UkrSSR

TITLE: Certain Design Features of Important Parts of Large Turbine Sets for Super-Critical Steam Conditions

PERIODICAL: Teploenergetika, 1960, Nr 2, pp 3-11 (USSR)

ABSTRACT: Turbine outputs and steam conditions both continue to rise, and Soviet turbine manufacturers are now developing sets of 300 atm and 650°C. These steam conditions will be used in the superposed 100 MW turbine type SKR-100 of the Khar'kov Turbine Works and also for single-shaft turbines of 400 and 500 MW of the Khar'kov and Leningrad works; 240 atm and 580°C will be used in the tandem turbines of 600 kW (Leningrad Metal Works) and 800 MW (Khar'kov Turbo-Generator Works). Although high steam conditions are most effective in large turbines, there are advantages in considering separately the problems of raising the steam conditions and of raising the overall output. This is because the difficulties associated with high steam conditions are concentrated at the inlet end of the turbine whilst those concerned with large outputs principally affect the

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Certain Design Features of Important Parts of Large Turbine Sets for Super-Critical Steam Conditions

exhaust end. The present article considers certain constructional features of the inlet and exhaust ends of large turbines for super-critical steam conditions: the arrangements adopted have an underlying general principle. Hitherto the problem of raising steam conditions has been one of finding suitable heat-resisting materials, and pearlitic-ferritic steels have been used successfully. However, operating experience with the Cherepetskaya GRES turbines type SVK-150 running at 170 atm and 550°C has shown the possibility of using austenitic steels. They withstand still higher steam conditions such as 650°C at 300 to 400 atm, which are limiting values with currently available materials. Nevertheless, austenitic steels are expensive and difficult to use and turbine designers are trying to find ways round these metallurgical problems. Recent work in this direction by the Khar'kov Turbine Works in collaboration with a number of scientific organisations has resulted in the design of the super-high pressure

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turbine type SKR-100. The underlying idea of this design is to separate the functions of heat-resistance and load-carrying. The large and heavy parts of the stator and rotor may then be made of relatively cheap pearlitic-ferritic materials. The only parts made of austenitic steels are those directly exposed to live steam, and they are so few and so small as to have little effect on the overall cost. The design problems that have arisen in fulfilling this idea are exemplified by describing an experimental turbine type SKR-100 rated 100 MW at 3000 rpm. It has stop-valve steam conditions of 300 atm and 650°C and reheat to 565°C and is intended for super-position on a medium-pressure turbine of 29 atm 400°C. In order to reduce the need for austenitic steel the turbine is made with two cylinders, the second being entirely of pearlitic steel as the steam temperature in it does not exceed 560°C. Two versions of the super-high pressure cylinder are made; one uses austenitic steel extensively, whilst the other conserves it by the adoption of features described below. The steam inlet

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arrangements and flow parts of the second version of the super-high pressure cylinder are illustrated in Figs 1 and 2 respectively. Live steam is admitted through four nozzle boxes to the first stage, where it expands to 246 atm and 628°C. It then passes through guide vanes and 10 reaction stages to reach a pressure of 162 atm at 550°C. About 20% of the exhaust steam from this cylinder flows over and cools the outer surface of the inner frame, and leaves the super-high pressure cylinder through auxiliary outlets near the main steam inlet valves. There are also two separate parallel flows of cooling steam drawn from the steam pipes beyond the governor valves and automatically cooled to a temperature of 520°C in cooling devices. The arrangements are illustrated schematically in Fig 3. One of these flows of steam cools the turbine stator and the other the rotor; details of the flow parts are given. After cooling the most heavily loaded parts of the stator and rotor, the cooling steam is mixed with the main flow and passes through the high-pressure cylinders. The chamber beyond

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the first stage contains guide vanes which separate the flows of main and cooling steam, so permitting use to be made of the outlet velocity from the first stage. During operation of the set and also during manufacture some changes may be made in the sections of the flow paths which would affect the degree of reaction. The flow of steam cooling the stator may be controlled according to temperatures measured at various places. The temperature fields in this design were investigated at the Khar'kov Polytechnical Institute at the instance of the Khar'kov Turbo-Generator Works and demonstrated the high efficiency of this system of cooling. With the turbine operating under rated conditions and with a flow of cooling steam of 12.5 tons per hour at an initial temperature of 525°C, the temperature of the rotor drum nowhere exceeds 540°C. A plot of the temperature field and diagram of heat flows in the blading and associated parts of the rotor of the reactive stage is given in Fig 4. Investigations also showed that the mean temperature of the heat flow over the entire reactive part, assuming no heat flow along the rotor, ranges from 540°C near the second stage to 530°C near the 11th. In practice the more intense cooling of the rotor under the guide vanes, and also the heating of the rotor near the 11th stage by a mixed flow of working and cooling steam, will equalise these temperatures. Fig 5 shows the temperature field of components of the super-high pressure cylinder under rated conditions, calculated by the method of Engineer Pereverzev. It has been shown that the rotor and casing temperatures nowhere exceed 540 to 550°C, so that the main large parts can be made of the conventional pearlitic steels. Thus the rotor is made of chrome-molybdenum-tungsten vanadium steel EI-415 and the casing of chrome-molybdenum vanadium steel 15 Kh-1M-1F-L. Austenitic steels are used only in the thin-walled parts of the steam inlet valve and in the super-high-pressure blading. There is not space to describe in detail other important features of the type SKR-100 turbine, including the sealing of the high-pressure steam ducts. It should be noted, however, that cooling is best arranged by using a reactive flow

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path, which is unusual for Khar'kov Turbine Works designs. The valves and seals in the super-high-pressure flow path were so well designed that the reactive design with cooling steam is as efficient as the impulse design with austenitic inner casing and rotor. However, the reactive design has a number of important advantages, namely: the flows of the working and the cooling steam are clearly separated; the use of annular chambers after each row of cooling channels facilitates uniform steam distribution in the cooling channels of the next row; there are no discs, which even if cooled would have to be made of austenitic materials. There is reason to suppose that the design features adopted in turbine type SKR-100 can be used for much higher steam conditions. It is to be expected that by this means turbines can be made with materials already developed for stop-valve steam temperatures up to 750 and possibly 800°C. The design of steam piping for super-high steam conditions presents serious difficulties, and similar design features might be used to improve matters. A possible solution, suggested by Candidate of Technical Sciences D. P.

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Varshavskiy and the present author in 1958 (Author's Certif. No. 118825), is a double-walled steam pipe, a schematic diagram of which is given in Fig 6. A pipe of austenitic steel is located inside an outer pipe, the intermediate space being connected to the inlet of the primary super-heater which delivers steam of lower temperature. The inner austenitic pipe through which live steam flows is mechanically unstressed. The outer tube is in contact with steam of comparatively low temperature (400 to 500°C) and can be made of pearlitic steel. The austenitic pipe is thin-walled (8 to 10 mm). Thermal insulation of the inner pipe presents problems as it must operate in high-pressure steam. A suggested design of double-piping for use with the SKR-100 turbine of 300 atm and 650°C is represented in Fig 7. Glass-fibre insulation is used for the inner pipe. When the amount of steam flowing between the pipes is 1% of the main steam flow its rate of flow is 0.25 m/sec. It enters at 430°C, is

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another steam main where it is heated to 480°C. With this design the outer pipe may be made of steel 12KhlMF with a wall thickness of 25 mm. It has been calculated that double-walled steam piping for the SKR-100 set will require about 15 tons of austenitic steel EYalT and about 100 tons of pearlitic steel, whereas the ordinary construction would use 90 tons of austenitic steel EI-695R. The price economy would be about 2 million roubles. Another way of separating temperature from stress in the pipework was proposed by engineers of the Khar'kov Turbine Works and is illustrated diagrammatically in Fig 8, which also shows calculated values of temperature in different parts of the steam piping. The inner thin-walled austenitic pipe is located inside a pearlitic pipe with a gap of about 25 mm. This gap is filled with metal insulation in the form of thin-walled austenitic sleeves which separate the flows of cooling medium. It is calculated that with this arrangement the inner surface of the pearlitic pipe does not exceed a temperature of 540°C, so that it can be made of steel

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12Kh1MF with a thickness of 40 mm. The outer surface of the pearlitic pipe is cooled by air which flows in a duct between the outside of the pearlitic pipe and a jacket of ordinary carbon steel; the hot air is used in the furnaces. The design of air-cooled piping is now being studied in more detail. It appears likely that it will be possible to develop pipe work with minimum amounts of austenitic steel not only for temperatures of 650°C but also for higher temperatures up to 800°C. Stop valves are still largely made of austenitic steel and there appears to be no immediate prospect of developing new designs. The outlet parts and condensers of steam turbines are very bulky and those for the largest turbines can no longer be transported whole. Thus, for the 150 MW turbine type PVK-150 the exhaust part of the turbine had to be made in two parts and the condenser in four. The 300 MW sets will present still greater difficulties. It is also difficult to make large parts under vacuum sufficiently rigid. One

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solution of this problem now being developed by the Khar'kov works again consists in separating the functions of the machine so that some of the parts under vacuum only provide rigidity and strength whilst others only provide sealing. The condenser case and part of the exhaust duct are made of reinforced concrete and also serve as the foundation for the low-pressure cylinders. The concrete is faced with thin sheets of steel or with other material to prevent contact with steam. In Fig 9 the arrangement is shown applied to the medium-and low-pressure turbine type K-300-240, of 300 MW. A brief description of the design is given. The concrete walls are air cooled, and special precautions are taken to prevent cooling air from leaking into the steam. To reduce the temperature of the exhaust ducts when operating on light loads, water is injected under automatic control. Still better results may be obtained by using protective coatings on the concrete. At the instance of the Khar'kov Turbine Generator Works a number of

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Certain Design Features of Important Parts of Large Turbine Sets for Super-Critical Steam Conditions

works in the development of such protective coverings capable of operating at temperatures up to 100°C. The advantages of reinforced concrete for the exhaust parts of large turbines are such that the works consider it advisable to use them for machines of 150 MW. It goes without saying that extensive development and operating experience is required to check these important new ideas. There are 9 figures and 3 Soviet references.

ASSOCIATION: Khar'kovskiy turbinnyy zavod (Khar'kov Turbine Works)

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SHUBFNKO-SHUBIN, L.A.

The last blade of a turbine. Izobr.i rats. no.3:3-6 Mr '60.
(MIRA 13:6)

1. Chlen-korrespondent Akademii nauk USSR, glavnyy konstruktor Khar'kovskogo turbinnogo zavoda imeni S.M.Kirova.
(Steam turbines)

SHUBENKO-SHUBIN, L.A.

Some constructional decisions concerning important units in high capacity turbine installations for supercritical steam parameters. Teploenergetika 7 no.2:3-11 F '60. (MIRA 13:5)

1. Khar'kovskiy turbinnyy zavod. Chlen-korrespondent AN USSR. (Steam turbines)

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E194/E184

21.2120

AUTHOR: Shubenko-Shubin, L.A. (Corresponding Member, AS Ukr.SSR)

TITLE: The Main Features of the Turbine Set Type K-300-240 KhTGZ

PERIODICAL: Teploenergetika, 1960, No 10, pp 6-13

TEXT: This article gives a fairly detailed description of the special features of turbine type K-300-240 which is a 300 MW machine for inlet steam conditions of 240 atm, 580 °C, with reheat to 565 °C. Data on the increased efficiency as compared with earlier types of machine are given in a Table. The turbine type K-300-240 was built at the suggestion of the works instead of the previously projected set type SVK-200 of 200 MW with steam of 220 atm, 600 °C, making extensive use of austenitic steel. Turbine K-300-240 can be made just as efficient as type SVK-200 but its steam conditions permit the use of well-established steels of the pearlitic (ferritic) class. Moreover, the size and weight of the 300 MW machine are little different from those of the SVK-200 machine whilst the labour costs and weight per kilowatt hour output of the K-300-240 set are 30% less than those of the turbine VKT-100. Because of their excellent characteristics turbines type K-300-240 will probably be

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widely used in large thermal power stations not only during the 1959-1965 Seven Year Plan but also probably long afterwards. This three-cylinder single shaft set running at 3000 r.p.m., a cross-sectional diagram of which is given in Fig 1, is intended for unit operation with a boiler of 900 tons/hour which delivers steam through four pipes of 175 mm diameter to the two groups of nozzle valves. Each nozzle group has one stop valve, 250 mm diameter, two governor valves 112 mm diameter and one of 75 mm diameter. The frames of the steam inlet valve which are under live steam conditions (240 atm 580 °C) are cast out of heat resistant pearlitic steel P-3 (15Kh2M2FBS) developed in the Central Scientific Research Institute and used here for the first time. Compared with steel 15Kh1M1F which has previously been used for parts operating at 565 °C, steel P3 has a higher content of chromium and molybdenum and to increase the resistance to oxidation it is alloyed with about 1% of silicon. As in recent new designs of the Khar'kov Turbine Works, the frame of the steam inlet part of the high-pressure cylinder of the turbine K-300-240 is made with double walled construction but this time without inserted nozzle boxes.

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This appears to be the first time that this construction has been used. It results in considerable simplification, reducing the size and wall thickness of the high pressure part. The procedure used to avoid the use of nozzle boxes is described. The high pressure cylinder contains one single row regulating stage and ten pressure stages and develops 100 MW. The stresses and temperatures are such that the high pressure rotor can be made of the familiar pearlitic steel EI-415. The steam leaves the high pressure cylinder at a pressure of 40 atm and temperature of 325 °C through two pipes 400 mm in diameter to the reheater, from which it is returned at a temperature of 565 °C to the lower part of the medium pressure cylinder through two reheat valves. In the medium pressure cylinder the direction of flow is opposite to that in the high pressure cylinder with the idea of reducing the thrust on the thrust bearings. However, if there is any deviation from the design conditions, such as might result from deposition of salts on the blading, substantial thrusts could still be developed and, therefore, the usual combined thrust and support bearing is replaced by a separate thrust bearing of balanced construction with self-adjusting pads (see Fig 2).

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A number of difficulties which were encountered in the design of the medium pressure cylinder are discussed; in particular the discs of the first two medium pressure stages are subject to high temperatures and loadings. In the medium pressure cylinder there are twelve stages which reduce the pressure to 2.3 atm, the main flow of steam thus being divided into three parts. One third of it passes to the five stages of the low pressure cylinder contained in the same frame as the medium pressure cylinder, whilst the other two thirds are passed through pipes of 1000 mm diameter to the low pressure cylinder in which each flow again passes through five stages.
The construction of the low pressure rotors is discussed; the discs are shrunk on to forged rotor shafts. The relative merits of this construction and of the welded rotors used in some other designs are considered and it is shown that in this particular type of machine the welded rotor offers no special advantages. The three flows of low pressure steam pass to a common condenser designed for a pressure of 0.035 atm with cooling water supplied at the rate of 35,000 m^3/hr at a temperature of 12 °C. The cooling surface of about 15,000 m^2 is formed by two main bundles of tubes. The turbine blading design

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is discussed; it is based on the most recent investigations in this field. In all stages of the turbine there is a small positive reaction of 2-3% at the blade roots, to avoid drawing steam from the space between the diaphragm and disc. Excess leakage over the blade tips is prevented by using radial glands. An interesting detail is that a special method of locking the blades in the medium pressure rotor was developed in which all the blading channels are uniform, which increases the overall efficiency of the medium pressure cylinder by about 1%. This system was designed by M.B.Yavel'skiy of the Khar'kov Turbine Works. An important technical achievement is the blading of the final stage which is 1050 mm long, with a peripheral speed of 565 m/sec, which is claimed to be without precedent. In recent years the Khar'kov Works has made great strides in the development of long blades. Unlike previous designs the blades of 1050 mm cannot be made so rigid that the lowest natural frequency under working conditions is over 100 c/s, i.e. between the second and third exciting harmonics. When running at the operating speed the frequency is about 90 c/s. Despite careful profiling of

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the blade the centrifugal force on each is over 120 tons and the maximum stress is 4300 kg/cm^2 (see stress diagram of Fig 3). It was accordingly necessary to use modified stainless steel type EI-802 for the blades. The methods of making the blades and of fixing them in the rotors are briefly described. The use of reheat greatly reduces the wetness of the steam passing through the later stages which in the case of the K-300-240 turbine is only 8.1%. This reduces the risk of erosive wear but there is still a risk of erosion because of the high peripheral speeds and it is the general experience of the works that with peripheral speeds of 450 m/sec and above with steam wetness greater than 5%, no protective coating of the leading edges of the blades can provide sufficient protection. Under such conditions the moisture must be removed directly from the blading. Such a system of water removal is used in the turbine K-300-240 where, as will be seen from Fig 1, the water is removed from the guide vanes of the last stage through an annular gap of special construction. The method of water removal is combined with protection of the leading edges of the working blades by electric spark deposition of wear resistant hard alloy.

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A rigid coupling is used between the high and medium pressure rotors with a common thrust bearing. The medium and low pressure rotors and the generator are connected by semi-flexible couplings which are rigid in the axial direction so that the set requires only one common thrust bearing. The first five critical speeds of the system of shafts of the K-300-240 set were calculated on a computer and are: 1,555 r.p.m., 1,870 r.p.m., 2,110 r.p.m., 2,180 r.p.m., and 4,660 r.p.m. The thermal circuit of the set is illustrated schematically in Fig 4. Steam is bled from eight points to heat the feed water to a temperature of 265 °C. Two other bleed points are used for the evaporators and can provide sufficient make-up to cover leaks of 2% of the maximum steam consumption, that is 890 tons/hr. Steam can also be tapped off at the rate of 15 Mkcal/hour to provide water for heating purposes. The feed pump is driven by a steam turbine using steam at a pressure of 15 atm tapped from the main set. The exhaust steam from the feed pump drive turbine is partly delivered to heat exchange equipment of the regeneration system and is partly returned to the main turbine at a pressure of 2.5 atm. The feed pump power

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is about 10,000 kW so its turbine is fairly efficient. Moreover, with turbine drive the pumps can be run at the most economic speed to suit the main set conditions. The control and protective system is described and a general schematic diagram of the control circuit is given in Fig 5. The turbine uses the system, previously developed by the works, of control with positive and negative hydraulic feed-back and double amplification. An important feature of the new system is that it uses water instead of oil as pressure medium. The water is delivered from the high pressure side of the condensate pumps to the main servo-motor at a pressure of 23 atm and into the first amplification line at a pressure of 12 atm. The use of water reduces the fire risk and makes it possible to use a higher pressure of working substance in the control system. All the signalling devices of the control and protective system (the speed governor, the overspeed governor, the vacuum regulator and others) operate on the water pressure in the first amplification line or in the protection line by altering the flow to the drainage system. Its design is such that remote control can be used and stable operation can be obtained under all conditions, maintaining the frequency in

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the electric power system within the required limits of 5%. If load is suddenly lost the turbine does not shut down completely but runs on no-load. Provision is made for further development of automation of the boiler turbine unit up to the stage of complete computer control. The control system checks 95 pressures, 140 temperatures, 115 control points and 30 other variables such as levels, flows, expansion, rotor eccentricity, and so on. Eighty-five warning and emergency signals are given and 75 valves and solenoids are remote controlled. Automatic electronic regulators control the level of condensate in the condenser and in heaters. The works has developed a considerable number of special indicating and recording instruments for the set which are briefly described. Special automatic equipment was required because the set works as a unit with the boiler. The equipment used for this purpose is of special interest and will form the subject of a separate article. There are 5 figures, 1 table.

ASSOCIATION: Khar'kovskiy turbinnyy zavod (Khar'kov Turbine Works)

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E194/E484

AUTHOR: Shubenko-Shubin, L.A., Corresponding Member AS UkrSSR

TITLE: Certain Technical-Economic Results and Development Prospects of Steam-Turbine Construction at the Khar'kov Turbine Works imeni Kirov

PERIODICAL: Energomashinostroyeniye, 1960, No.11, pp.1-6

TEXT: The Khar'kov Turbine Works was able to recommence the design and manufacture of large steam turbines for power stations only 5 - 6 years ago. In 1955-56 the technical staff determined the main lines of technical development in steam turbine manufacture, namely the construction of turbines in the largest possible sizes and increasing their efficiency by using the highest possible steam conditions consistent with minimum use of austenitic steel. In 1957, the works manufactured the first condensing turbine type ВКТ-100 (VKT-100) of 100 MW at 3000 rpm with initial steam conditions of 90 atm and 535°C. This type of set was over 6% more efficient than the previously used ВК-100-2 (VK-100-2). Construction of turbines type ПВК-150 (PVK-150) of 150 MW commenced in 1958, this uses a steam pressure of 130 atm and a temperature of 565°C with reheat to 565°C. The first

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Certain Technical-Economic Results and Development Prospects of Steam-Turbine Construction at the Khar'kov Turbine Works imeni Kirov

150 MW turbine in Europe was constructed in Leningrad in 1953, it was a three cylinder set making extensive use of austenitic steel. As compared with this set the turbine PVK-150 of the Khar'kov Works has the advantages that it is more efficient, it has only two cylinders with two-way flow in the low pressure cylinder, so that the turbine is smaller and indeed little bigger than a 100 MW set. It was possible to use the two cylinder design because of a number of improvements in the design and manufacture particularly in the extensive use of welding and the use of very long blades in the last stage. No parts are made of austenitic steel. Turbines type PVK-150 will be one of the main types used in power stations built in the period 1959-1965. At the beginning of 1957, the works suggested that turbine type K-300-240 (K-300-240) of 300 MW with initial steam conditions of 240 atm and 580°C using only pearlitic steel should be developed instead of a proposed turbine of 200 MW. This proposal was taken up and found to be much cheaper per installed kilowatt. In 1959, the drawings for the turbine type K-300-240 were completed and the first such set will be built in 1960. This is a three cylinder single-shaft set

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working as a unit with the boiler from which the steam passes to two groups of nozzle valves. The governor valves are built as a unit with the stop-valve and separate from the turbine, the valve frame is cast of pearlitic steel grade П-3 (P-3). The high-pressure cylinder is of two-wall construction with steam delivered directly to the inner cylinder without inserted nozzle boxes. On leaving the high pressure cylinder the steam is reheated to 565°C at 35 atm before passing to the medium pressure cylinder, the frame of which also includes five stages of one of the low pressure flows, the other two stages being in the third cylinder unit. In the control hydraulic system of turbine K-300-240 oil is replaced by water taken from the pressure side of the condensate pumps which reduces the fire risk. The reheat conditions are described. A most important achievement in this turbine is the working blade of the last stage which is 975 mm long with a peripheral velocity of 542 m/sec. Recent advances in the construction of large turbine blades at the Khar'kov Works are illustrated by the dimensioned diagram of Fig.1 and the data given in Table 1.

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Certain Technical-Economic Results and Development Prospects of Steam-Turbine Construction at the Khar'kov Turbine Works imeni Kirov

Development of these 975 mm blades opens the door to further advances using steam conditions of 240 atm and 580°C which practically exhausts the possibility of pearlitic steels. Accordingly, these steam conditions with reheat to 565°C should be used for large turbines in the period 1959-1965. Using an exhaust stage blade length of 975 mm there would be no difficulty in constructing a 400 MW four cylinder turbine but it is considered better to make the next step 500 MW with four cylinders on one shaft, see Fig.2a. With 975 mm blades in a 500 MW machine the condenser vacuum could not be better than 0.04 atm which is, however, acceptable. To secure further increases in size, it is necessary to split the steam flow in the medium as well as in the low pressure cylinders using tandem construction for example, to produce a 600 MW turbine К-600-240 (K-600-240), shown diagrammatically in Fig.2b. The only major design difference between this and the K-300-240 turbine would be in the high pressure cylinders. With tandem construction and a 975 mm last stage blade the turbine output may be raised to 750 to 800 MW, the best variant

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being shown in Fig.2B, which could also be used for a 1000 MW set if somewhat higher discharge velocity losses are permitted. A prototype of any of these turbines could be manufactured by 1962 provided that projects for the station as a whole have been worked out and the order is given in good time. The technical characteristics of recent turbines of 100, 150 and 300 MW are compared in Table 2 and are discussed at some length. The attention that has been paid in recent years to improving the design of the high-pressure part of the turbine has now about reached its limit and similar attention should now be concentrated on the low-pressure end, which is probably where the main losses are. The graph of Fig.3 shows expected changes with different sizes of set in the next few years in (1) heat consumption per kilowatt, (2) weight per kilowatt and (3) labour cost of manufacture. The courses that these curves are expected to follow are discussed and the reasons are explained. Table 3 gives information about the number of parts in turbines of 100 MW and 300 MW and shows the increased tendency to use standardized parts and to cut down on new

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drawing office work. Fig.4 gives information on the man-hours spent in manufacturing turbines of 100 and 150 MW as experience has accumulated. Fig.5 shows a graph of the increase in output of steam turbines from the Khar'kov Works taking 1955 as 100%, the figure is 630% in 1960 and should be 1060% by 1965, the increase so far has been achieved from the same manufacturing space. Fig.6 shows graphs of the changes in numbers of different categories of staff taking 1955 as 100%, the number of workmen has remained about constant, the engineering and technical staff has increased to 143.5%, the design staff to 182% and the laboratory staff to 255%. The data plotted in Fig.7 shows the increase in earnings in recent years whilst the actual manufacturing cost of turbines has decreased. Not only is the number of engineering and technical staff increasing but so is their general level of qualifications. More use is being made of computers and other methods of increasing designers' output. To secure further advance it is important to develop at the works a strong development and experimental basis and further to strengthen the engineering-technical service. There are 7 figures, 3 tables and 4 Soviet references.

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SHUBENKO-SHUBIN, L.A.; LAZARENKO, A.V., inzh.

PVK-150 steam turbine built by the Kharkov turbine plant. Energomashinostroenie 7 no.6:1-7 Je '61. (MIRA 14:7)

1. Chlen-korrespondent AN USSR (for Shubenko-Shubin).
(Steam turbines)

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SHUBENKO-SHUBIN, L.A.

Basic characteristics of the K-300-240 turbine unit manufactured by the Kharkov Turbogenerator Plant. Teploenergetika 7 no.10:6-13 O '60. (MIRA 14:9)

1. Khar'kovskiy turbinnyy zavod. 2. Chlen-korrespondent AN USSR (for Shubenko-Shubin).
(Kharkov—Turbines)

SHUBENKO-SHUBIN, L.A.; KAPLAN, M.P., inzh.

"Gas turbines; theory and design" by IA.I.Shnee. Reviewed by L.A. Shubenko-Shubin, M.P.Kaplan. Energomashinostroenie 7 no.10: 43-44 O '61. (MIRA 14:10)

1. Chlen-korrespondent AN USSR (for Shubenko-Shubin).
(Gas turbines) (Shnee, IA.I.)

SHUBENKO-SHUBIN, L.A.

Concerning the future types of high-capacity steam turbine units. Teploenergetika 8 no.8:3-12 Ag '61. (MIRA 14:10)

1. Khar'kovskiy turbinnyy zavod. Chlen-korrespondent AN USSR.

(Steam turbines)

SHUBENKO-SHUBIN, L.A.; KORZH, P.I., inzh.; KAPLAN, M.P., inzh.; PALEY, V.A., inzh.

Gas turbines for large power stations. Teploenergetika 8 no.11: 5-12 N '61. (MIRA 14:10)

1. Khar'kovskiy turbinnyy zavod. 2. Chlen-korrespondent AN USSR (for Shubenko-Shubin).
(Gas turbines)
(Power engineering)

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E194/E355

AUTHOR: Shubenko-Shubin, L.A., Corresponding Member of the AS Ukrainian SSR

TITLE: The development of turbine manufacture at the Khar'kov Turbine Works

PERIODICAL: Teploenergetika, 1961, No. 10, pp. 23 - 29

TEXT: The main trends of turbine development are: firstly, the manufacture of large sets whose size is limited only by the degree of reliability required of the system; secondly, the development of sets of higher efficiency, not only by raising the steam conditions but also by design improvements. Until 1956 the works produced only three types of steam turbine of 25 and 50 MW; in the last five years they have developed nine types, in ratings up to 300 MW. The first condensing turbine type ВКТ-100 (VKT-100) of 100 MW at 3 000 r.p.m. was developed in 1957. This two-cylinder turbine had many new design features and operated at steam conditions of 90 atm. and 535 °C. It was substantially more efficient than earlier types. A particularly important design feature was the

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last-stage blading 740 mm long, with a mean diameter of 2 085 mm. The design has proved reliable and satisfactory in service.
The first steam turbine type ПВК-150 (PVK-150) of 150 MW at 3 000 r.p.m. was made in 1958. This turbine, together with type ПВК-200 (PVK-200) of the LMZ represent a considerable step forward. The steam conditions are 130 atm. and 565/565 °C, using only pearlitic and ferritic steel. They are substantially more efficient than the 100 MW turbines. The labour required, metal content and the demands upon factory floor space are relatively less than for the 100 MW machines because of the extensive use of welding, for example, in the use of a welded low-pressure rotor. In the turbine PVK-150 welded parts and assemblies comprise 70% of the total weight of the set.
The first sets, type PVK-150, were put into operation at the beginning of 1960. At this time, a considerable number of turbines of this type had been manufactured but, of course, there had been no opportunity to modify the features which had caused initial teething troubles in service. Thus,

unfortunately, at present the works have the problem of putting into service and adjusting a large number of sets rather than a single prototype. However, experience has already shown that these sets, type PVK-150, are very flexible and can be started up and shut down simply and reliably. There is as yet no accurate data about the actual efficiency of the sets though preliminary data indicate that the fuel consumption is within guarantee.

In 1960 the works manufactured the first turbine of 300 MW type K-300-240. This is a single-shaft three-cylinder set with steam conditions of 240 atm. at 580 °C with reheat to 565 °C. As a result of these changes the turbine type K-300-240 will be 17% more efficient than type VKT-100 and the resultant annual fuel economy approximates to the cost of the actual set. An important achievement in this turbine is the last-stage blade of 1 050 mm, running at 3 000 r.p.m., which has made it possible both to construct a set of this output with only three cylinders and to make it highly efficient.

To make three 100 MW turbines requires 50% more labour than to

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make one type K-500-240, moreover, the savings in power-station construction are very great. Because of the advantages of large sets, the works designed in 1960 a single-shaft set, type K-500-240 of 500 MW and a two-shaft set, K-800-240, of 800 MW for operation with steam conditions of 240 atm. at 580 °C. Unfortunately, no decision has yet been taken about the manufacture and starting-up of these sets. Moreover, the Komitet po avtomatisatsii i mashinstroyeniyu pri Sovete Ministrov SSSR (Committee of Automation and Engineering of the Council of Ministers of the USSR) has not only not yet examined the designs for these machines produced by the works but apparently does not even intend to do so during 1961. This is likely to delay turbine manufacture in our country and to inflict damage on Soviet power engineering.
The steam conditions used in the turbine K-300-240 (240 atm. and 580 °C) have practically exhausted the possibilities of using cheap and simple steels of the pearlitic class. Further increase in stop-valve temperature requires the use of austenitic steels which, on the basis of present-day knowledge, could operate with
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steam temperatures up to 650 °C at pressures up to 300 atm. Because of manufacturing and operating difficulties with austenitic steels, in 1961 the works manufactured for experimental operation a superposed turbine, type CKP-100 (SKR-100) of 100 MW for steam conditions of 300 atm. and 650 °C. However, the use of expensive heat-resistant materials is not the only way of raising steam temperatures and pressures. For example, the hotter parts of machines may be cooled and this procedure is being used in another variant of machine, type SKR-100, which is now being manufactured. Experience with this machine under operating conditions will give the necessary information for designing sets with the initial steam temperatures in the range 750 - 800 °C using austenitic steels in very small amounts. With the changing fuel balance and the increased availability of gas, power gas-turbines are attracting attention and in 1960-1961 the works made the first gas turbine of 50 MW which is now being erected at a district-heating station and should soon be on test. This experimental 50 MW gas turbine, type ГТУ-50-800 (GTU-50-800) is intended for power generation

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and delivery of heat for district heating. It uses the open cycle and has three stages of air compression and two stages of gas expansion and regeneration. The fuel is natural gas. With an air temperature of 20 °C it generates 50 MW at the generator terminals: the gas temperature at the high-pressure combustion chamber is 800 °C and at the low-pressure combustion chamber 770 °C. The overall compression ratio is 18, the degree of regeneration is 0.75 and the air consumption is 200 kg/sec. The efficiency at the generator terminals at 100% load is 33.5%, at 75% load 31.0% and at 50% load 27.0%. The set has a two-shaft arrangement. The gas temperature of 800 - 770 °C in this set is somewhat higher than that used hitherto in Soviet gas turbines. However, the cooling methods in this turbine make it possible to use pearlitic steel. It is calculated that the life of such parts as the rotor is about 100 000 hours; the runner blades of the first stage in the high- and low-pressure turbines should be replaced after 30 000 hours at full load. It has been calculated that for power stations with a total installed capacity of 200 - 300 MW

the gas turbine type GTU-50-800 is more economic than steam turbines.
Operating experience with the new gas turbine will lead to further development; in 1960 the works designed a set of 100 MW but considered that it should not be manufactured until teething troubles with the 50 MW set have been overcome. For major power engineering developments gas turbines of some hundreds of MW are required and it has been calculated that with currently permissible gas temperatures of 750 - 800 °C it is quite possible to develop gas turbines of up to 200 MW. However, the efficiency of such turbines would be lower than that of the most recent steam turbines using steam conditions of 240 atm. and 580 °C. A more promising arrangement for base load sets is the steam-gas cycle, the efficiency of which is 8-10% higher than that of steam sets of the same steam conditions. The wide introduction of sets of this kind depends directly on the successful development of such gas turbines as GTU-25 of the LMZ and GTU-50 of the KhTGZ and of high-pressure steam generators. In recent years the design staff of the works has increased by

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more than 30% whilst the number of workmen has remained approximately the same and labour productivity has greatly increased. Thus the output of steam turbines reckoned by rating has increased by a factor of 4.5 and the cost per installed kilowatt has been reduced by a factor of 2.5. Research and development work at the factory should be extended and the already extensive cooperation with outside institutes and laboratories should be strengthened. In the last two or three years the works has organised its own steam-gas laboratory which has already obtained important results. It has provided data on the operation of the latter stages of large turbines, particularly under wet steam conditions. There are 2 figures, 2 tables and 5 Soviet references.

ASSOCIATION: Khar'kovskiy turbinnyy zavod (Khar'kov Turbine Works)

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SHUBENKO-SHUBIN, Leonid Aleksandrovich; IVANOV, S.M., red.; RAKITIN, I.T., tekhn. red.

[Special turbines]Unikal'nye turbiny. Moskva, Izd-vo "Znanie," 1962. 32 p. (Novoe v zhizni, nauke, tekhnike. IV Seriia: Tekhnika, no.23) (MIRA 15:11)

1. Glavnyy konstruktor Khar'kovskogo turbinnogo zavoda chlen-korrespondent Akademii nauk Ukr. SSR (for Shubenko-Shubin).
(Turbines)

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PHASE I BOOK EXPLOITATION

Shubenko-Shubin, Leonid Aleksandrovich, Corresponding Member, Academy of Sciences USSR, David Mikhaylovich Gerner, Natan Yakovlevich Zel'des, Vilor L'vovich Ingul'tsov, Vladimir Zel'manovich Kogan, Moisey Yosifovich Pokrassa, Sergey Petrovich Sobolev, Viktro Pavlovich Sukhinin, Anatoliy Vitol'dovich Trzhetsinskiy, Avadiy Yefimovich Shneydman

Prochnost' elementov parovykh turbin (Strength of Steam Engine Parts) Moscow, Mashgiz, 1962. 567 p. Errata slip inserted. 4000 copies printed.

Reviewer: B. M. Panshin; Ed.: R. A. Nikiforova, Engineer; Tech. Ed.: M. S. Gornostaypol'skaya; Chief Ed.: Mashgiz (Southern Dept.): V. K. Serdyuk, Engineer.

PURPOSE: This book is intended for steam-turbine designers and service and engineering personnel in the steam-turbine industry. It may also be useful as a special textbook for teachers and students specializing in the steam- and gas-turbine industry.

Card 1/11

SHUBENKO-SHUBIN, L.A.; KAPLAN, M.P., inzh.

Justification of the effecient types of combined gas-and-steam plants for high capacity power production. Toplenergetika 9 no.11:2-10 N '62. (MIRA 15:10)

1. Khar'kovskiy turbinnyy zavod. 2. Chlen-korrespondent AN UkrSSR (for Shubenko-Shubin).
(Power plants—Design and construction)

SHUBENKO-SHUBIN, L.A.

A 300,000 kilowatt capacity steam turbine. Biul.tekh.-ekon. inform. no.1:53-55 '62. (MIRA 15:2)

1. Chlen-korrespondent AN USSR.
(Steam turbines)

S/114/62/000/004/002/008
E114/E654

26.2120

AUTHOR: Shubenko-Shubin L.A. Corresponding Member AS UkrSSR,
Sobolev, S.P. and Poznakhirev, V.F., Engineers

TITLE: Design of last stage blading for large steam turbines.

PERIODICAL: Energomashinostroyeniye, no.4, 1962, 5 - 10

TEXT: Unit output is limited by the maximum permissible length of the last stage turbine blade. The authors discuss the present state of art and describe methods used in the design of blades at the Khar'kovkiy turbinnyy zavod imeni Kirova (Khar'kov Turbine Works imeni Kirov (KhTGZ). A table is given showing the main characteristics of longest blading developed in various countries in Europe and U.S. A. and claiming that the longest blades already in service, 1050 mm., were made in USSR and correspond to the peripheral speed of 565 m/sec. Blade design proceeds by successive approximations. The first approximation of permissible blade length is given as a function of the specific gravity and elastic limit of the blade material, r.p.m., the ratio of total blade stress to the stress in an

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S/114/62/000/004/002/008
E114/E654

Design of last stage ...

equivalent blade of uniform cross-section, safety factor and a ratio of mean diameter of the stage to blade length. The optimum design leads to minimum stresses in the blade by determining the appropriate relative position of different blade sections and of the whole blade relative to the disc. The following forces acting on a blade were taken into account: centrifugal, bending due to steam loading, bending moment due to spatial difference between the centre of gravity of a section and its projection onto the centre of gravity of the complete blade. Certain stresses were neglected, such as bending due to steam loading relative to the axis of the maximum moment of inertia, torque due to action of centrifugal force on a bent blade of variable section and action of the working fluid on a bent blade, bending stress due to forming the blade by bending and also bending due to the temporary deformation of the blade by the

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S/114/62/000/004/002/008
E114/E654

Design of last stage ...

centrifugal forces. Usual formulae are given for the centrifugal stress in the blade at a given section. For ease of calculation the bending moments due to steam loading are calculated separately in tangential and axial direction and then added vectorially. The eccentric action of the centrifugal force on any given intermediate section of the blade causes a bending stress relative to the axis of the minimum moment of inertia. A general approximate equation is derived. The stress in the blade can be reduced by inclining the blade bodily in axial or tangential directions; or its working part can be displaced with respect to its root. Or, most effective of all, it can be bent tangentially. When, by these means, the stresses on the leading and the trailing edge and on the back of the blade are all made equal, it will correspond to the minimum total stress in the blade. An example is given of a calculation for a blade to be formed by milling, with rotation and bending. The basis

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S/114/62/000/006/001/006
E194/E155

AUTHORS: Shubenko-Shubin, L.A., Corresponding Member of the Academy of Sciences Ukr.SSR, and Ostrovskiy, S.I., Engineer

TITLE: Cooled steam turbine of KhTGZ, type CKP-100 (SKR-100) for super-critical steam conditions

PERIODICAL: Energomashinostroyeniye, no.6, 1962, 4-10

TEXT: A 100 MW, 3000 r.p.m. turbine with initial steam conditions of 300 atm and 650 °C with reheat to 565 °C, is described. Maximum steam consumption is 690 tons/hour with an output at the generator terminals of 101 380 kW. The turbine is designed for super-position on a medium-pressure turbine and operates against a back pressure of 31 atm. Numerous design problems were raised by the high steam conditions, necessitating several prototype variants of the first superposed turbine, so as to have a proved supercritical pressure end similar in size to that of a 300 MW condensing turbine. A two-cylinder construction was used, the first cylinder being made in two variants: one exploiting new austenitic steels in a cylinder of proved design;

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and one 'cooled' in which the use of austenitic steels is reduced to a minimum. This latter type was made first. The first cylinder has one impulse and ten reaction stages, and its exhaust steam conditions are 162 atm, 550 °C. The second cylinder has ten stages, and after the third the steam is reheated to 100 atm, 565 °C. Solid couplings are used between the turbine shafts and between turbine and alternator. Cooling of the first cylinder was facilitated by the use of reaction blading which, combined with efficient glands, gives as high efficiency as the impulse blading of the austenitic variant. In the first cylinder the blading, nozzle boxes and steam delivery pipes are made of austenitic steel grade ЭИ-612 (EI-612); all other parts are made of pearlitic steel, the rotor of grade ЭИ-415 (EI-415) and the casings of grade 15Х1М1ФЛ (15Kh1M1FL). The cooling steam is tapped from the steam lines beyond the governor valves and is cooled by water injection to 520 °C; it is delivered in two separate flows, one of which mainly cools the rotor and the other mainly cools the inner casing of the first cylinders. Valves regulate the flows of steam to produce the required temperatures.

The steam inlet unions have three walls, a thin inner one being of austenitic steel. It is exposed to high-temperature steam and imposes only a slight pressure drop, being separated by a small clearance containing a little cooling steam from a surrounding screen tube which is itself externally cooled. At the inner end of the steam union the flow of cooling steam is split. Part passes over the outer wall of the inner casing to a chamber ahead of the first stage runner, from which some of it goes to cool the high pressure end gland; the rest of it cools the first stage blade roots. The other part passes through the clearance between the outer screen and the main cylinder. Cooling steam then passes over the roots of guide and rotor blades, thus avoiding excessive temperature in the rotor and the main cylinder. Beyond the last stage the cooling steam mixes with the main flow. The special arrangements that are made to overcome differential expansion effects are described. The nozzle boxes are screened from the main cylinder block, so that its temperature does not exceed 540 °C. The super-high pressure glands, of special design, are made of steel grade 1X18H9T (1Kh18N9T). Preliminary design studies of the

cooling system were made on electrical models in the Khar'kovskiy politekhnicheskiy institut (Khar'kov Polytechnical Institute) and on steam models in the works laboratories. It was found that the rotor temperature ranged from 542 °C near the second stage to 532 °C near the eleventh. The rate of flow of cooling steam is 20 tons/hour. Because reaction-type blading is used the flows of main and cooling steam are effectively separated, so that operation of the cooling system is not affected by changes in radial clearance of the main flow. Other general design features are described including the interesting point that both oil and water are used as governor system hydraulic fluids, to reduce the fire risk. The first turbine type SKR-100 will undergo full-scale trials at the Kashira Regional Power Station, the cooled variant being used first as the most promising. There is reason to believe that the design features embodied in this turbine will make it possible to design large turbines for inlet steam temperatures of 700-750 °C using proved materials and mainly austenitic.
There are 7 figures and 1 table.

SHUBENKO-SHUBIN, L.A.; SHVARTS, V.A., inzh.

"Regeneration systems and regenerators of gas turbine plants" by IU.M.Dedusenko. Reviewed by L.A.Shubenko-Shubin, V.A.Shvarts. Energomashinostroenie 8 no.1:37 Ja '62. (MIRA 15:3)

1. Chlen-korrespondent AN USSR (for Shubenko-Shubin).
(Gas turbines) (Dedusenko, IU.M.)

SHUBENKO-SHUBIN, L.

Giant turbines. Nauka i zhyttia 11 no.1:17-19 Ja '62.
(MIRA 15:2)

1. Chlen-korrespondent AN USSR, glavnyy konstruktor Khar'kovskogo turbinnogo zavoda im. S.Kirova.
(Steam power plants)

SHUBENKO-SHUBIN, L.A.; SOBOLEV, S.P., inzh.; POZNAKHIREV, V.F., inzh.

Thermal calculations and analysis of laws governing the twisting of the terminal stages of large steam turbines. Energomashinostroenie 8 no.10:1-6 O '62. (MIRA 15:11)

1. Chlen-korrespondent AN UkrSSR (for Shubenko-Shubin).
(Steam turbines)

Z/019/63/020/002/003/006
E073/E335

AUTHOR: Shubenko-Shubin,

TITLE: Steam turbine sets CHTGZ for large power generating sets

PERIODICAL: Energetika a elektrotechnika. Přehled technické a hospodářské literatury, v. 20, no. 2, 1963, 64, abstract E63-837 (Elektricheskiy stantsii, 33, no. 6, 1962, 2 - 8)

TEXT: The article records comparatively the features and characteristics of the 100, 150 and 300 MW steam turbines built by Khar'kovskiy zavod (Khar'kov Works) and estimates the savings achieved by up-rating. 7 figures and 1 table.
[Abstracter's note: complete translation.]

Card 1/1

LISETSKIY, Nikolay Leontiyevich; SHVARTS, V.A., inzh., retsenzent; SHUBENKO-SHUBINA, L.A., red.; CHISTYAKOVA, L.G., inzh., red.; GORNOSTAYPOL'SKAYA, M.S., tekhn. red.

[High-capacity gas turbines] Gazovye turbiny bol'shoi moshchnosti. Moskva, Mashgiz, 1963. 69 p. (MIRA 16:7)

1. Chlen-korrespondent AN Ukr.SSR (for Shubenko-Shubina).
(Gas turbines)

L 10518-63 EWP(r)/EWT(m)/BDS--EM

ACCESSION NR: AP3001027 S/0114/63/000/005/0001/0006

AUTHOR: Shubenko-Shubin, L. A. (Corresponding member, AN USSR) 51

TITLE: Some solutions to problems on free vibrations 26 of turbine blades with variable cross sections 26

SOURCE: Energomashinostroyeniye, no. 5, 1963, 1-6

TOPIC TAGS: turbine blade, turbine, vibration frequency, turbine-blade vibration

ABSTRACT: The problem of free vibrations of turbine blades with variable cross sections is considered. A differential equation of the fourth order used for calculating blade vibrations is reduced to two independent equations of the second order which apply to a wide range of rods with variable cross sections. The equations have been used to calculate the frequency of vibration of ten different turbine blades with variable cross sections. The method gives results sufficiently accurate for preliminary turbine-blade calculations. Orig. art. has: 50 formulas, 2 tables, and 3 figures.

ASSOCIATION: none

Card 1/2

SHUBENKO-SHUBIN, L.A.; FRIDMAN, A.Ye., inzh.; NEMIROV, V.S., inzh.

About Professor I.I. Kirillov's book "Automatic control of steam and gas turbines." Energomashinostroenie 9 no.7:42-43 Jl '63. (MIRA 16:7)

1. Chlen-korrespondent AN UkrSSR (for Shubenko-Shubin).
(Turbines) (Automatic control)
(Kirillov, I.I.)

SHUBENKO-SHUBIN, L., Geroy Sotsialisticheskogo Truda, glavnyy konstruktor parovykh turbin

Talk with a visitor. Znan.-sila 38 no.5:23 My '63. (MIRA 16:11)

ACCESSION NR: AP4045905 S/0114/64/000/009/0001/0005

AUTHOR: Shubenko-Shubin, L. A. (Corresponding member AN UkrSSR); Sobolev, S. P. (Engineer); Poznakhirev, V. F. (Engineer)

TITLE: Designing the profile of rotor blades for the last stages of high-power steam turbines

SOURCE: Energomashinostroyeniye, no. 9, 1964, 1-5

TOPIC TAGS: turbine, steam turbine, turbine blade, turbine blade shape

ABSTRACT: Methods of blade profile design are considered which envisage production techniques imposing certain limitations on the design, such as plano-milling by profile cutters. A set of "aerodynamically complete profiles" is used in the designing. All sections of the blade profile are designed simultaneously. Schemes for forming the profile and internal blade surface are given and discussed. Two methods for a variable outlet angle -- by turning the profile and

ACCESSION NR: AP4045905

by forming the outlet edge through great-radius arcs — are set forth. The blade is designed on the basis of a specified-stress-vs.-blade-height curve which satisfies the minimum total tensile-stress requirement. The blade is defined by a set of equations which includes certain parameters and the distance of the section in question to the hub end. Orig. art. has: 6 figures and 17 formulas.

ASSOCIATION: Khar'kovskiy turbinny*y zavod im. S. M. Kirova (Khar'kov Turbine Plant)

SUBMITTED: 00 ENCL: 00

SUB CODE: PR NO REF SOV: 003 OTHER: 000

Card 2/2

SHUBENKO-SHUBIN, L.A., doktor tekhn. nauk, prof.; KAPLAN, M.P., inzh.

Concerning B.V.Rebrov's book "Marine gas turbine systems." Energomashinostroenie 11 no.7:47 Jl '65. (MIRA 18:7)

1. Chlen-korrespondent AN UkrSSR (for Shubenko-Shubin).

SHUBENKO-SHUBIN, L.A.; POZNAKHIREV, V.F., kand. tekhn. nauk

Approximate numerical method for calculating a three-dimensional flow in a steam turbine stage. Teploenergetika 12 no.11:25-29 N '65. (MIRA 18:10)

1. Khar'kovskiy turbinnyy zavod im. S.M. Kirova i Institut mekhaniki AN Uk: SSR, Khar'kovskiy filial.

SHUBERNETSKIY, V.Ya., Cand Biol Sci -- (diss) "Comparative analysis of sexual reproduction in higher plants." Kishinev, 1958, 15 pp (Moskovskaya Oblast Pedagogical Inst im N.K. Krupskaya) 150 copies (KL, 50-58, 123)

SHUBERT, A.M.

History of the origin of experimental psychological studies in psychoneurological institutions. Trudy Gos. nauch.-issl. inst. psikh. 43:304-309 '65. (MIRA 18:9)

SHUBERSKIY, Aleksandr Nikolayevich, 1875-1955

[On the 25th anniversary of the inauguration of General Golovin's courses in military science in Belgrad] K 25-tiletiiu so dnia osnovaniia Vyschikh voenno-nauchnykh kursov professora generala Golovina v Gelgrade. Mentona, Frantsiia, 1955. 64 p. (MIRA 10:8)

(Belgrad--Military art and science)
(Golovin, Nikolai Nikolaevich)

SHUBERT, A.M.

25321 SHUBERT, A.M. O Nekotorykh Osobennostyakh Narusheniya Intellektual'noy Deyatel'nosti Pri Lobnykh Travmakh. Sborik Nauch. Rabot Psikhiatr. Bol'nitsy Im. Kashchenko, No. 6, 1949, S. 56-59
20. Dermatologiya. Venerologiya

SO: Letopis' No. 33, 1949

SHUBERT, D.M., inzh.

Using slags in construction. Stroi.prom. 27 no.6:17-18 Je '49. (MIRA 13:2)

(Slag)

SHUBERT, D. M.

USSR/Engineering - Construction, Equipment 15 Jul 52

"Mechanized Concrete-Mortar Plant," D. M. Shubert, Engr

"Byul Stroit Tekh" No 14, pp 18-20

PA 228T81

Describes plant at which all operations of mixing concrete and mortar are completely mechanized. Plant employs 30 workmen and produces 100-120 cu m of concrete and 90-95 cu m of mortar each shift. Productive capacity of one workman per shift amounts to 11 cu m of concrete and 4.65 cu m of mortar. Prepn of 1 cu m of concrete takes 0.72 man-hr.

228T81

SHUBERT, K.

A simple radio receiver for "hunting foxes." Radio no.12:24 D '61. (MIRA 14:12)

1. Redaktor zhurnala "Funkamator", Germanskaya Demokraticheskaya Respublika.

(Radio-receivers and reception)
(Radio direction finders)

SHUBERT, N. A.

Mbr. Clinic Exptl. Therapy of Psychoses, Inst. Psychiatry, Min. Public Health, -c1949-. Med. Nurse, Hosp. in Sokov'yev -c1949-. "General Nursing of Mental Cases in a Psychopathic Hospital," Med. Sestra., No. 4, 1949.

SHUBERT, S. A.

"Investigation of the Expansion of Filtering Charges in the Washing Process." Thesis for degree of Cand. Technical Sci. Sub 24 May 49, Academy of Communal Economy imeni K. D. Pamfilov.

Summary 82, 18 Dec 52, Dissertations Presented For Degrees in Science and Engineering in Moscow in 1949. From Vechernyaya Moskva, Jan-Dec 1949.

MINTS, D.M.; SHUBERT, S.A.; KIRSANOV, M.V., red.; GUROVA, O., tekhn. red.

[AKKh filters and calculations for washing high rate filters] Fil'try AKKh i raschety promyvki skorykh fil'trov. Moskva, Izd-vo M-va kommun. khoz. RSFSR, 1951. 173 p. (MIRA 11:8)
(Filters and filtration)

SHUBERT, S.; MINTS, D.

Filters and Filtration

First results of the use of AKKh filters. Zhil.-kom.Khoz. 2 No. 8, 1952

9. Monthly List of Russian Accessions, Library of Congress, December 1952 Uncl.

MINTS, Daniil Maksimovich, doktor tekhnicheskikh nauk; SHUBERT, Sergey Aleksandrovich, kandidat tekhnicheskikh nauk; SOKOL'SKIY, I.F., redaktor; KONYASHINA, A., tekhnicheskiy redaktor.

[Hydraulics of granular materials] Gidravlika zernistykh materialov. Moskva, Izd-vo Ministerstva kommunal'nogo khoziaistva RSFSR, 1955. 110 p. (MIRA 9:5)

(Fluidization)

SHUBERT, S. A.

USSR/Chemical Technology. Chemical Products and Their Application--Water Treatment. Sewage water   I-12

Abs Jour: Ref Zhur-Khimiya, No 3, 1957, 9134

Author : Shubert, S. A.
Inst : Not given
Title : Experience with the Application of AKKh Filters in Drinking Water Supply Systems

Orig Pub: Vodosnabzheniye i san. tekhnika, 1955, No 2, 1-3

Abstract: The following recommendations are made on the basis of the generalized experience with the operation of 40 AKKh filters in drinking water supply systems: thickness of the supporting gravel bed, 450-550 mm; thickness of the filter sand bed, 1150-1500 mm (d_{10} 0.45-0.55 mm and d_{80} 1.5-1.6mm); underdrain system, high-resistance piping with a center drain of perforated vinyl plastic pipe. The breakage of the vinyl plastic pipes which have been observed

Card 1/2

USSR/Chemical Technology. Chemical Products and Their Application--Water Treatment. Sewage water I-12

Abs Jour: Ref Zhur-Khimiya, No 3, 1957, 9134

Abstract: is traced to the incorrect operation of the filters, i.e., their too-rapid backwashing after drainage for repair or inspection.

Card 2/2

PODLIPSKIY, Viktor Aleksandrovich, glavnyy inzhener; ~~SHUBERT, Sergey~~ Aleksandrovich, starshiy nauchnyy sotrudnik; SEROBYEV, M.P., redaktor; SOKOL'SKIY, I.F., redaktor izdatel'stva; ZHOROV, D.M., tekhnicheskiy redaktor

[Experience in using new equipment in the Ufa water supply system] Opyt primeneniia novoi tekhniki na Ufimskom vodoprovode. Moskva, Izd-vo Ministerstva kommunal'nogo khoziaistva RSFSR, 1956. 94 p.
(MLRA 10:2)

1. Ufimskiy trest "Vodokanalizatsiya" (for Podlipskiy) 2. Akademiya kommunal'nogo khozyaystva im. K.D.Pamfilova (for Shubert)
(Ufa--Water supply)

SHUBERT, S.A.; PERLINA, A.M.; KULZHINSKIY, V.I.; SIDENKO, T.K.; ALEKSANDROV, D.N.; SOKOLOV, V.F.; FAL'KOVSKAYA, L.N.; BRUK-LEVINSON, T.L.; BELYAKOVA, A.N.; KOZHEVNIKOVA, Ye.K.; AVRUSHCHENKO, R.A., red. izd-va; VOLKOV, S.V., tekhn.red.

[Water purification for water supply to machine-tractor stations and state farms] Ochistka vody dlia vodosnabzheniia poselkov MTS i sovkhozov. Moskva, Izd-vo M-va kommun.khoz. RSFSR, 1957. 69 p. (MIRA 11:6)

1. Akademiya kommunal'nogo khozyaystva, Moscow.
(Water--Purification) (Water supply, Rural)